Innovative Water Resource Technology:
Using GRACE Satellite Data in California's Central Valley

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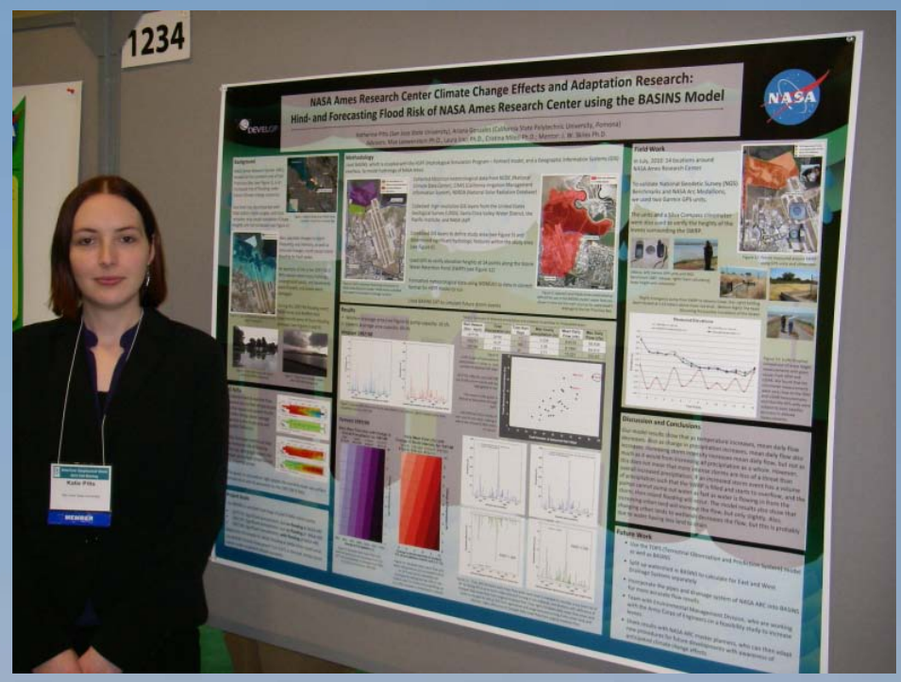
NASA DEVELOP National Program

- 9-10 week summer internship
- Paid
- Using NASA data to solve real world problems
- Student-run and student-led

2011 Summer Interns

Groundwater level measurements in West Sacramento



Katie Pitts at American Geophysical Union (AGU)

"Training the next generation of Earth Explorers"

THE GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE)

Key Questions

- Q1: What is GRACE?
- Q2: What data can be obtained from GRACE and how are these data useful?
- Q3: How is GRACE currently being used and does GRACE data compare with current water resource management tools (such as C2VSim)?
- Q4: How can GRACE be used for future water resource management?

THE GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE)

Q1

THE GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE)

Q1

- Twin satellites with tandem polar orbits
- Launched March 2002
- Uses microwave ranging system to measure inter-satellite distance
- Measures the distribution of mass above and below the Earth's surface
- Resolution = a few hundred km
- Data is not a point measurement, but a spatial average

NASA, University of Texas, 2011

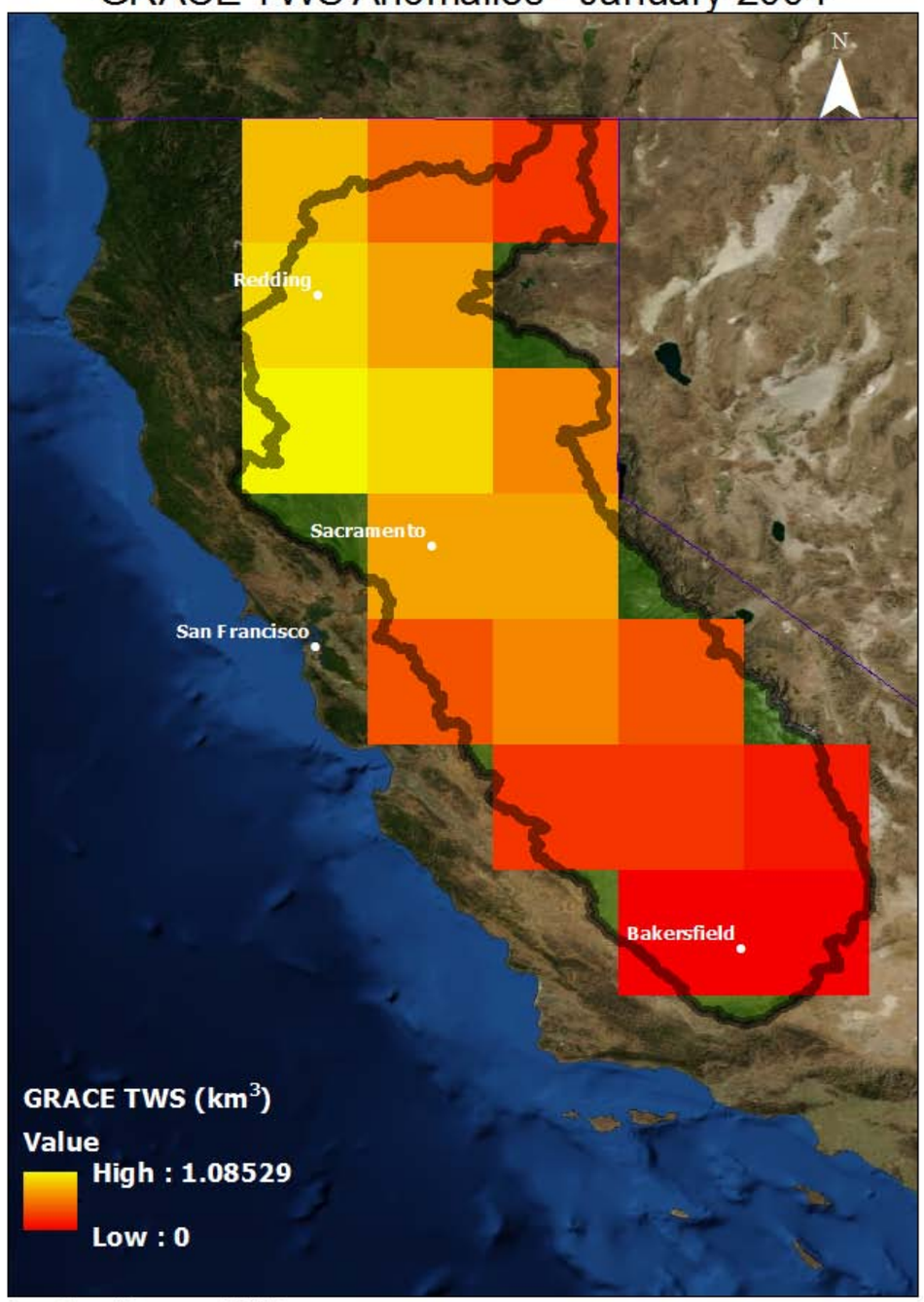
NASA, University of Texas, 2011

Q2 GRACE DATA IN THE CENTRAL VALLEY

California's Central Valley

NASA DEVELOP National Program
Coordinate System: GCS WGS 1984

GRACE TWS Anomalies - January 2004

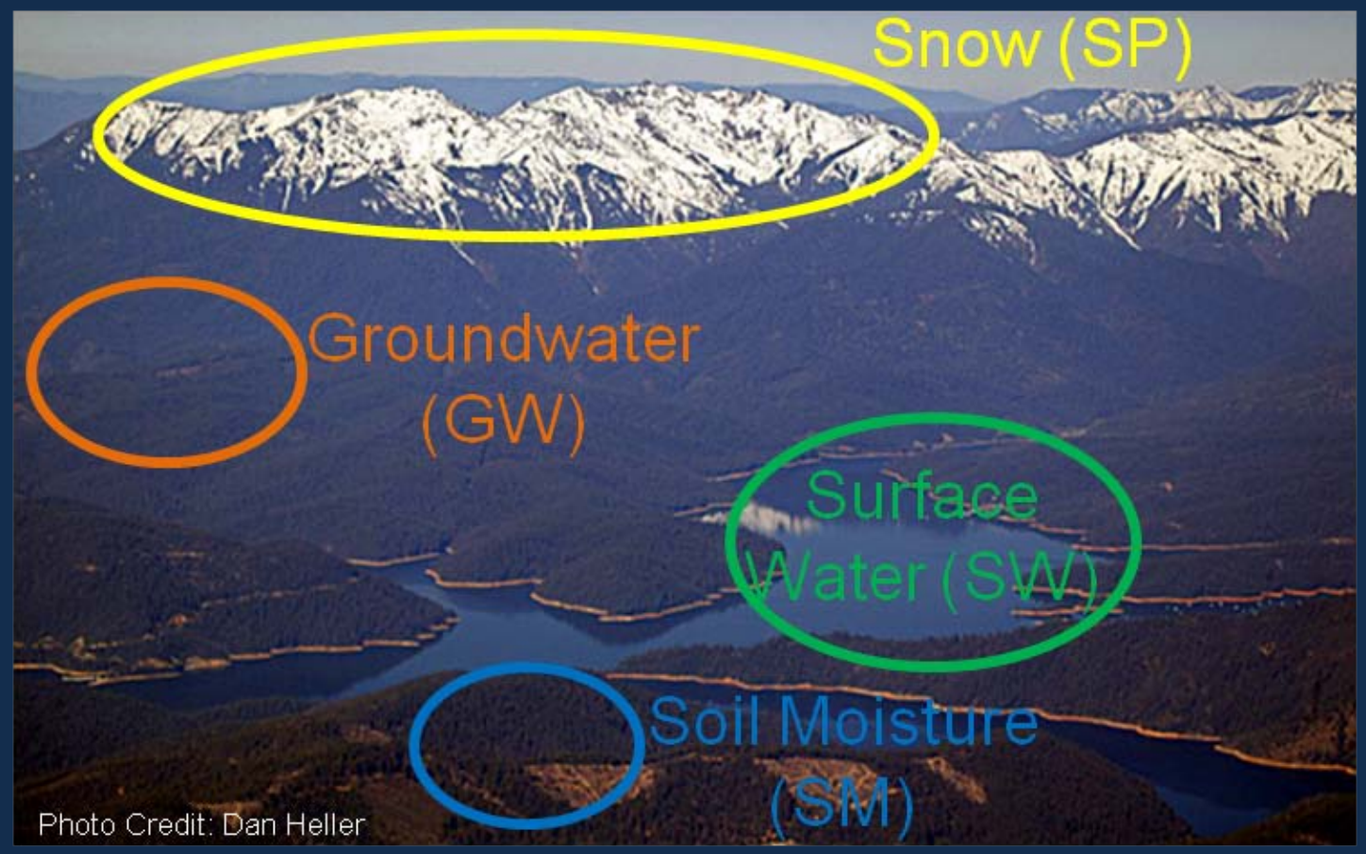


NASA DEVELOP National Program
Coordinate System: GCS WGS 1984

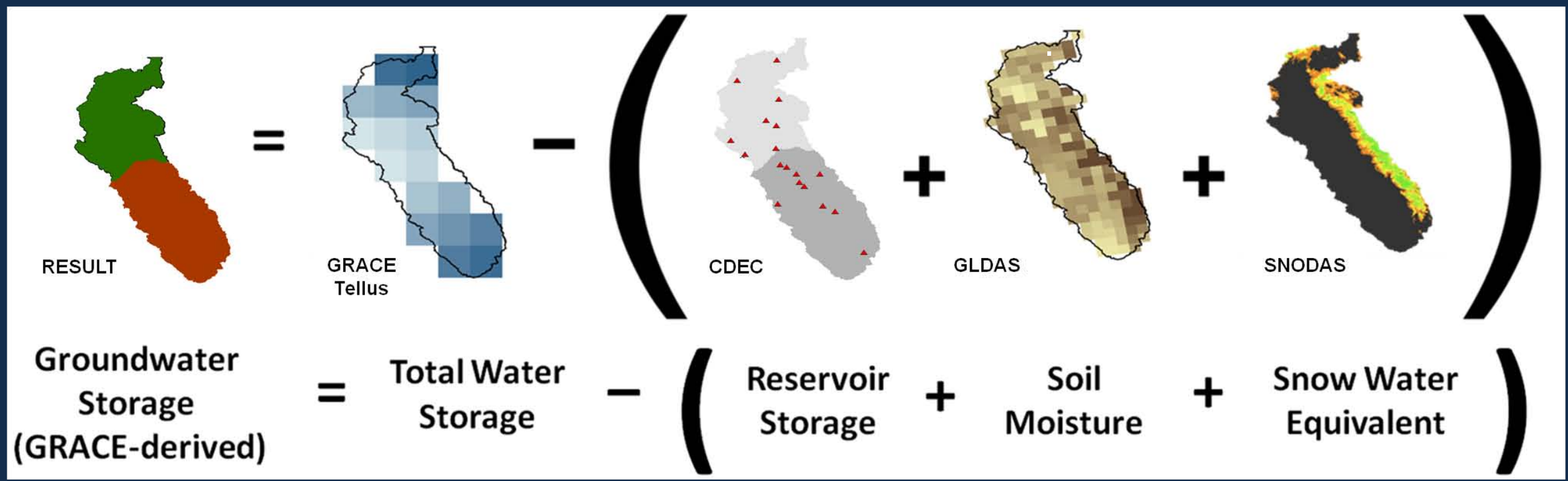
GRACE-DERIVED GROUNDWATER

Q2

- TWS=



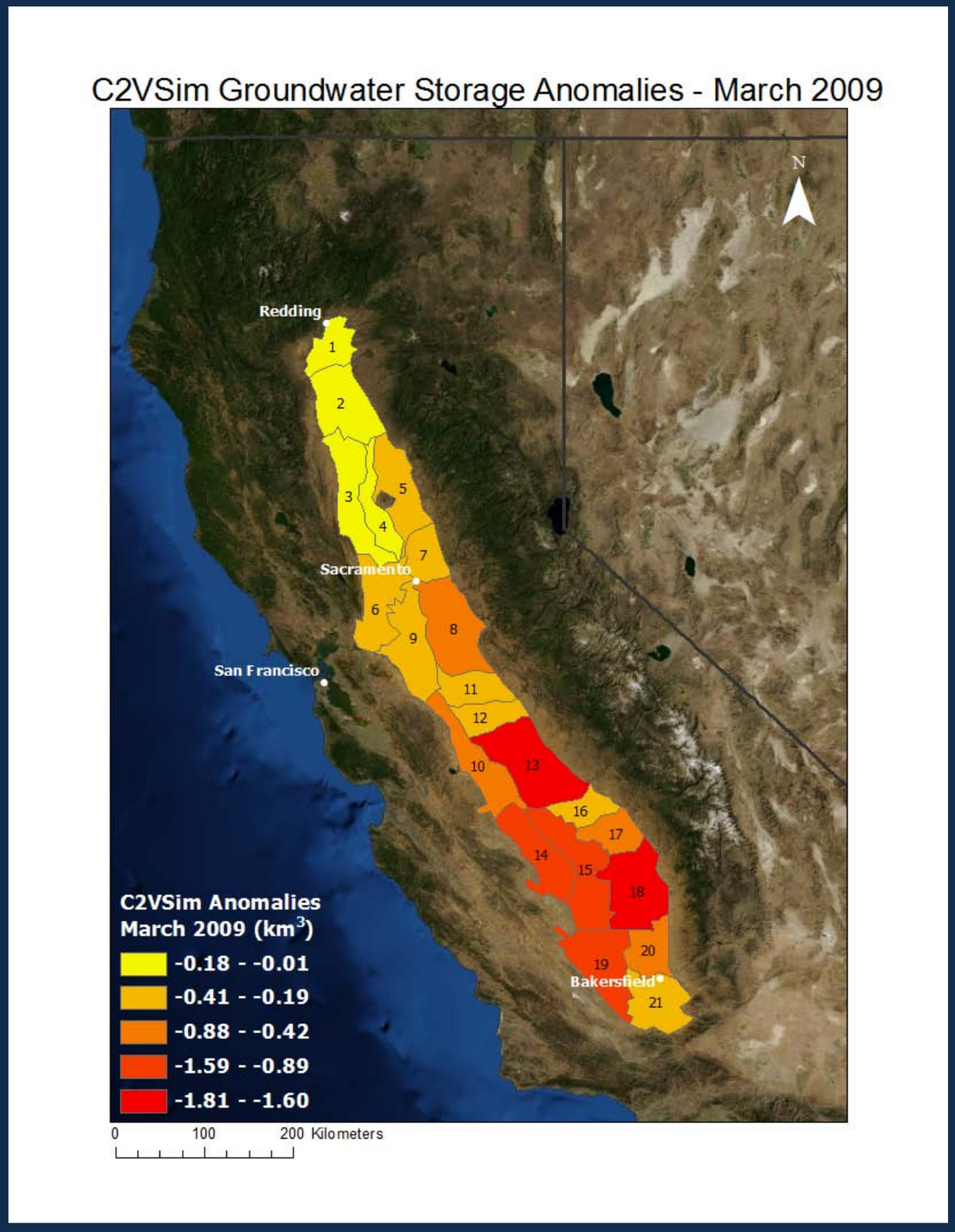
- - Each component was obtained and monthly anomalies were generated to subtract from TWS anomalies.



GRACE AND C2VSIM

Q3

- A finite-element hydrological model built to estimate water storage in the Central Valley aquifer
- Can calculate groundwater storage anomalies for each month to compare with GRACE
- Was also used in our project to downscaled GRACE data to the sub-region level



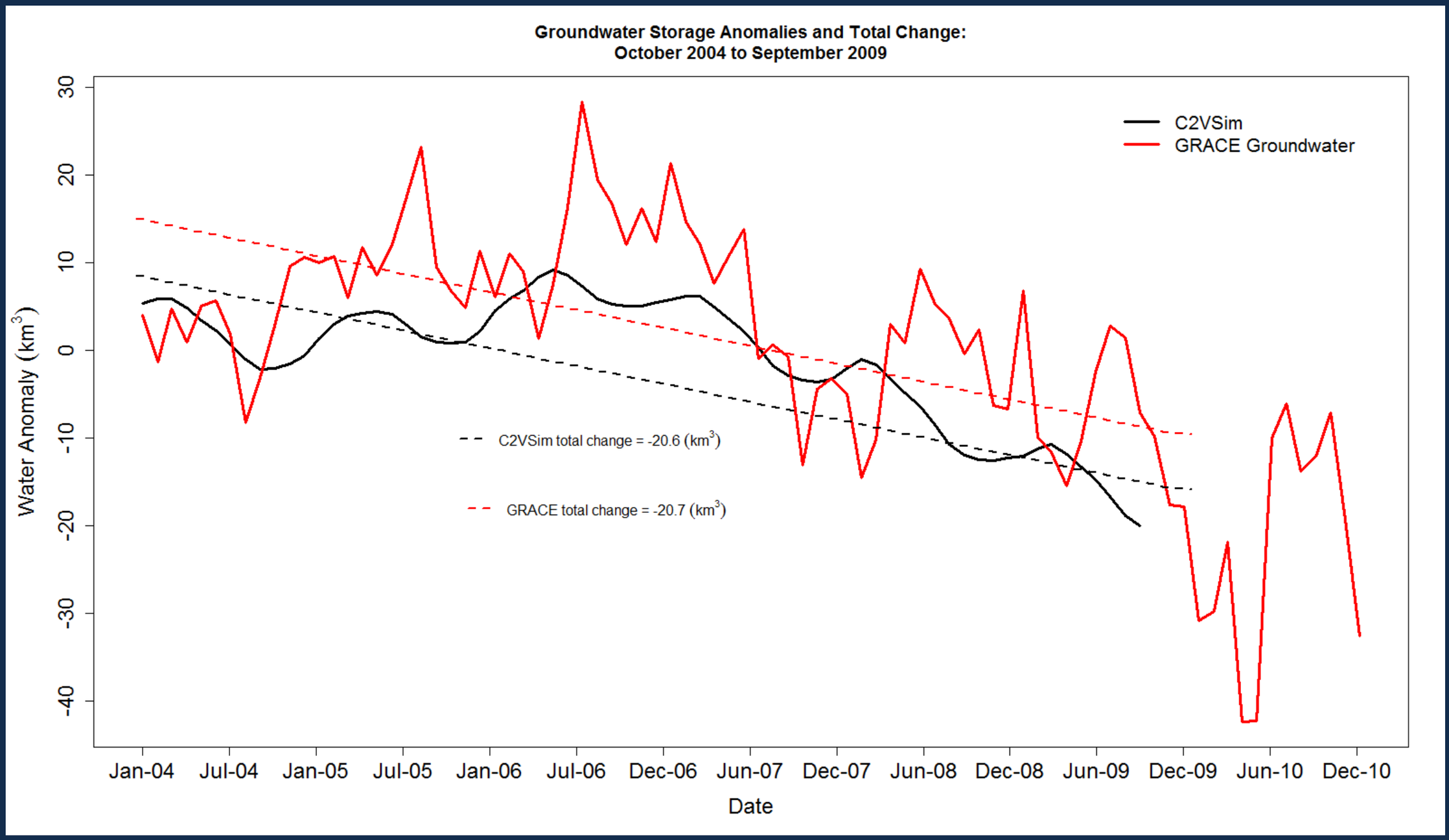
COMPARISON OF GRACE AND C2VSIM

Q3

Total change over the time period October 2004 to September 2009

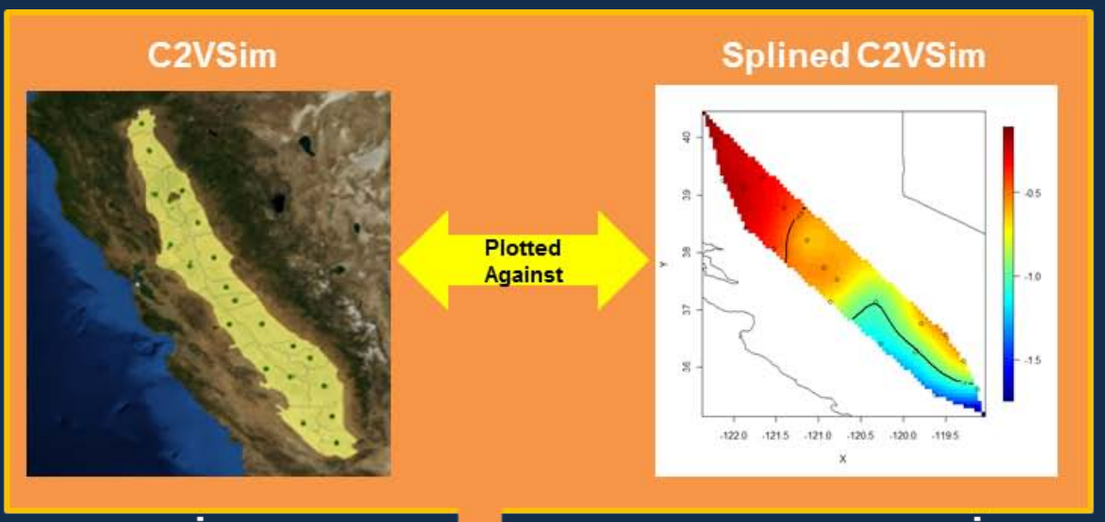
C2VSim total change = -20.6 ±3.01 km^3

GRACE downscaled change = -20.7 ±7.57 km^3



DOWNSCALING METHODOLOGY

Q4



Step 1) A linear equation was generated using C2VSim GW storage and splined C2VSim GW storage.

Calibration:
1924-2003

Validation:
2004-2009

Prediction:
2010

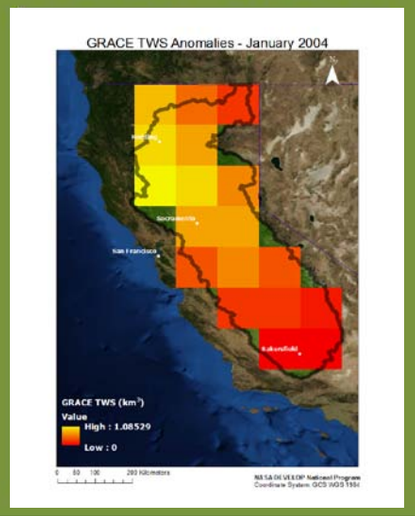
$Y = m.x + b$

Apply equation

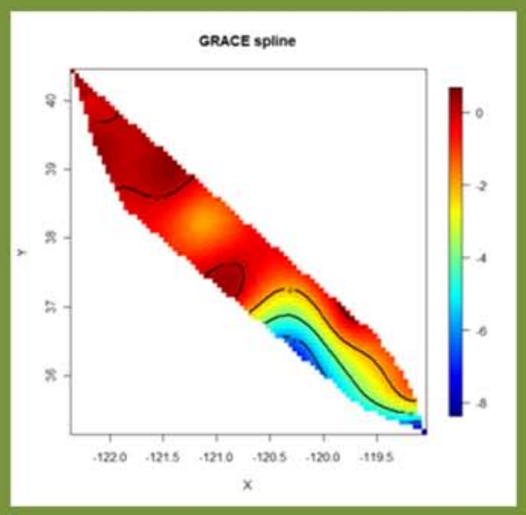
Downscaled GRACE GW Data

Step 3) Apply linear equation to the GRACE data.

GRACE derived GW Data
(1 degree x 1 degree grid)



X= Splined GRACE GW Data

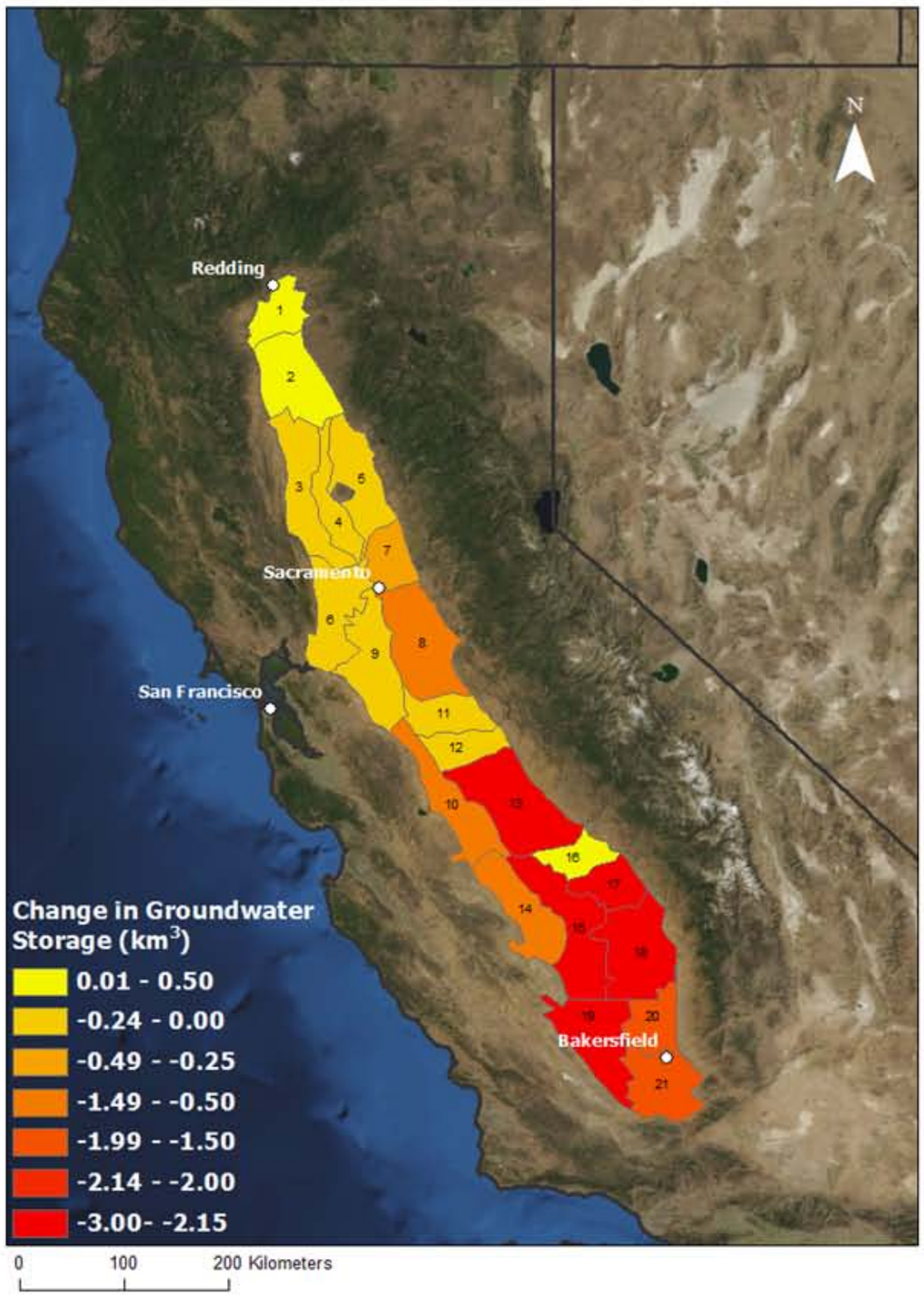


Step 2) The new release 5 GRACE-derived GW storage data were then splined.

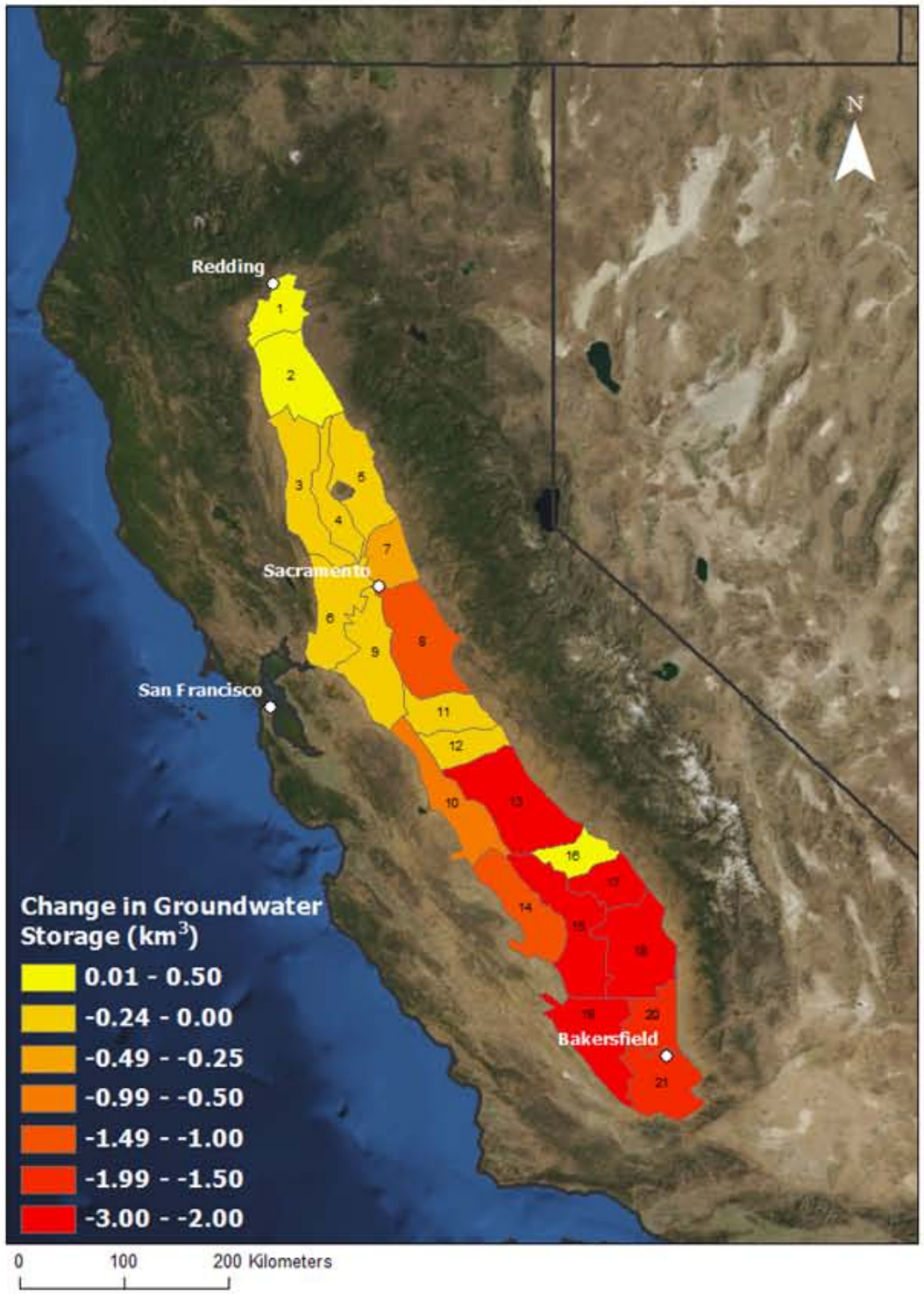
GROUNDWATER STORAGE ESTIMATES

Q4

C2VSim Change in Groundwater Storage
October 2004 - September 2009



Downscaled GRACE Change in Groundwater Storage
October 2004 - September 2009



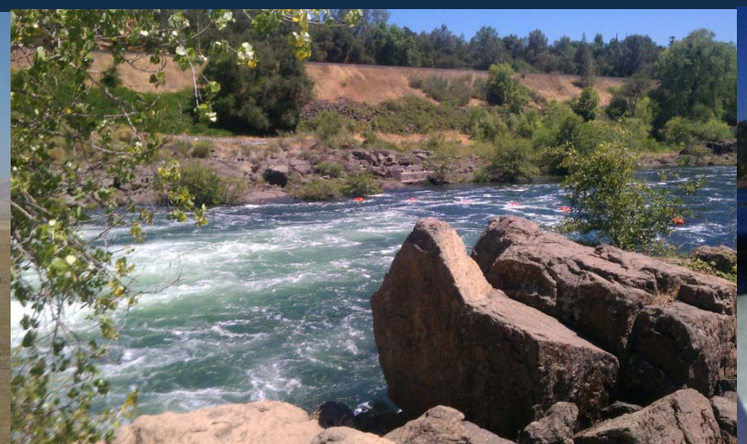
CONCLUSIONS

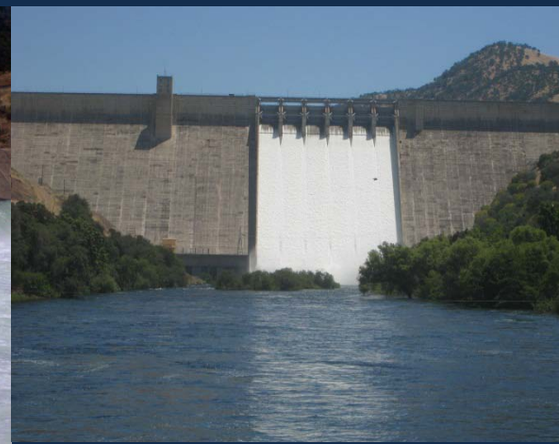
- GRACE measures variations in the Earth's gravitational anomalies, which can be used to estimate total water storage (TWS) and groundwater (GW) storage anomalies.

- The resolution of GRACE is coarse, and therefore is generally used in large hydrologic regions.

- GRACE GW storage estimates are comparable to hydrological models (C2VSim) for the entire Central Valley.

- C2Vsim can be used as a proxy for downscaling GRACE data to the sub-region level, however additional research must be completed to address the error involved in these estimates.



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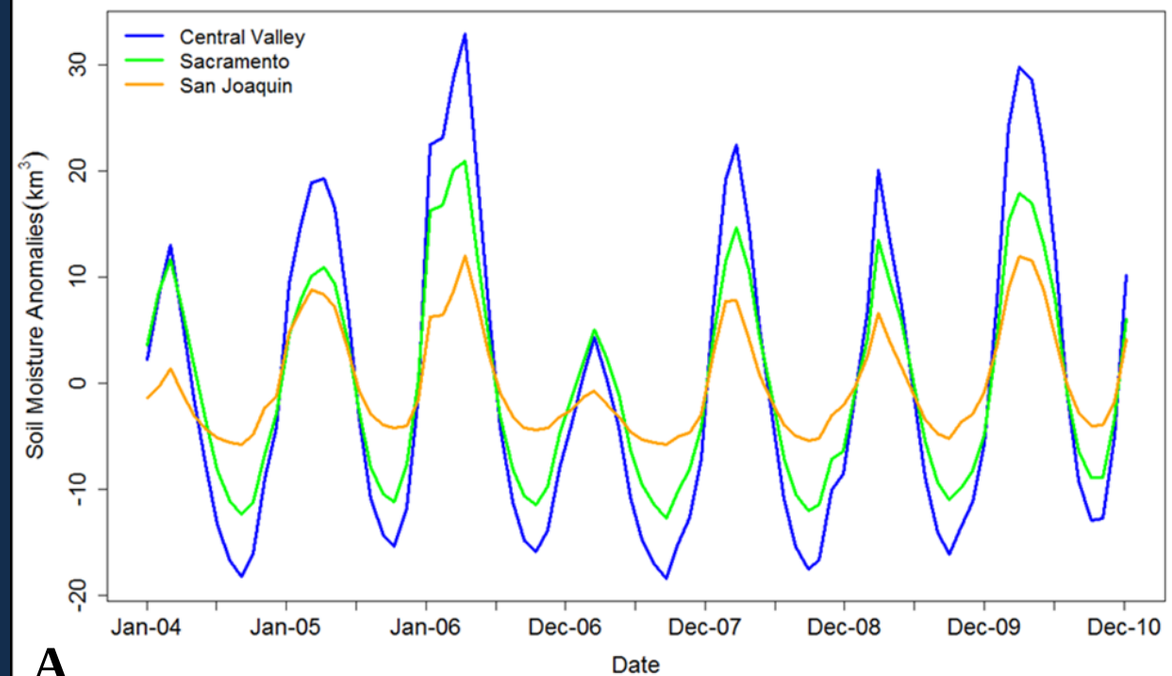
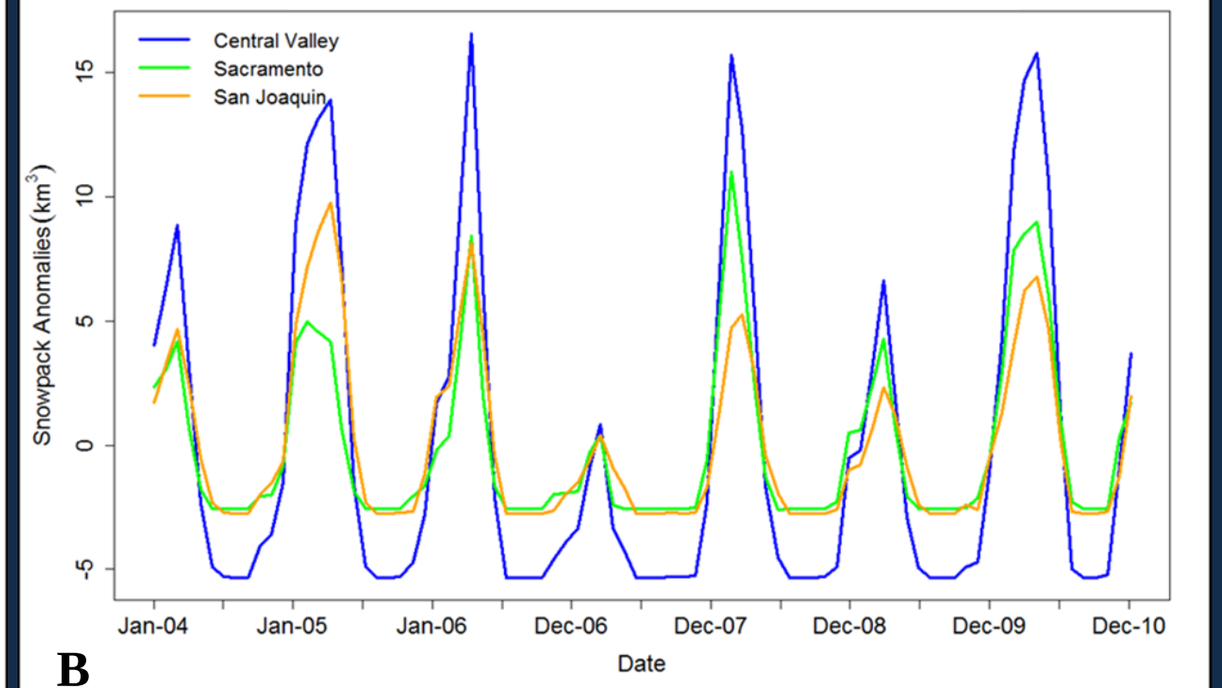
ADDITIONAL FIGURES

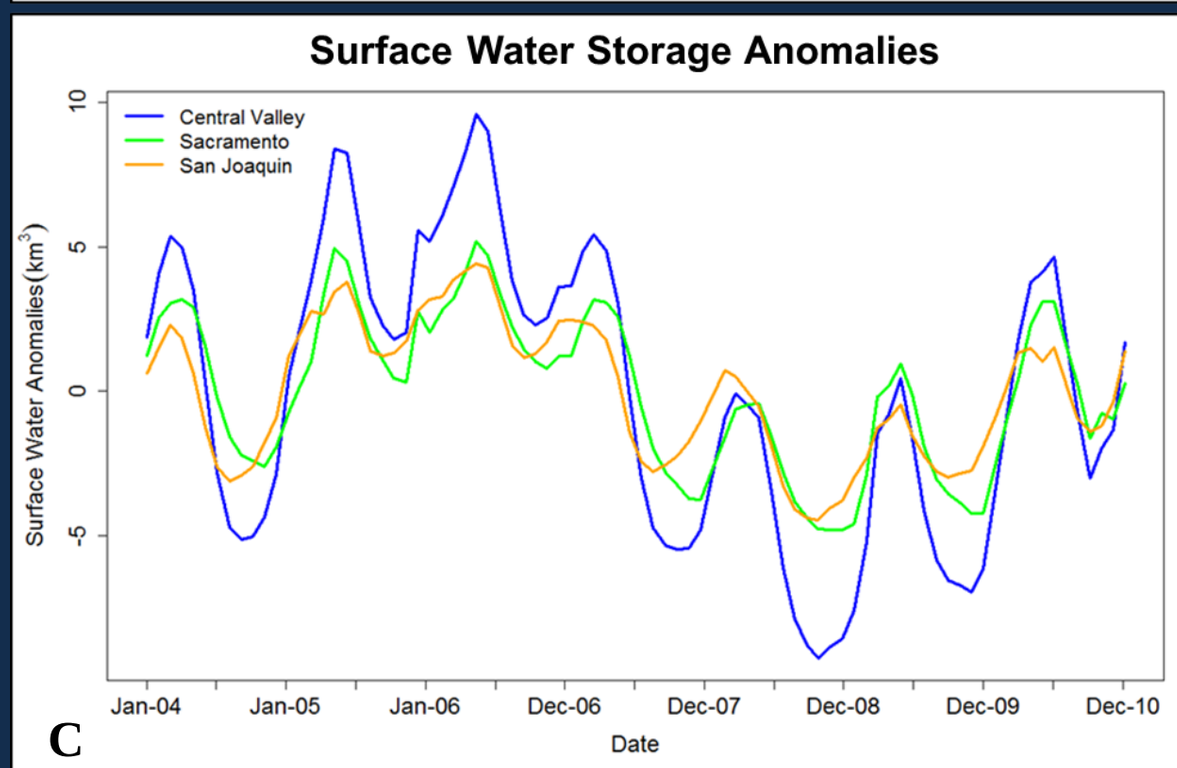
To be referenced only for additional questions

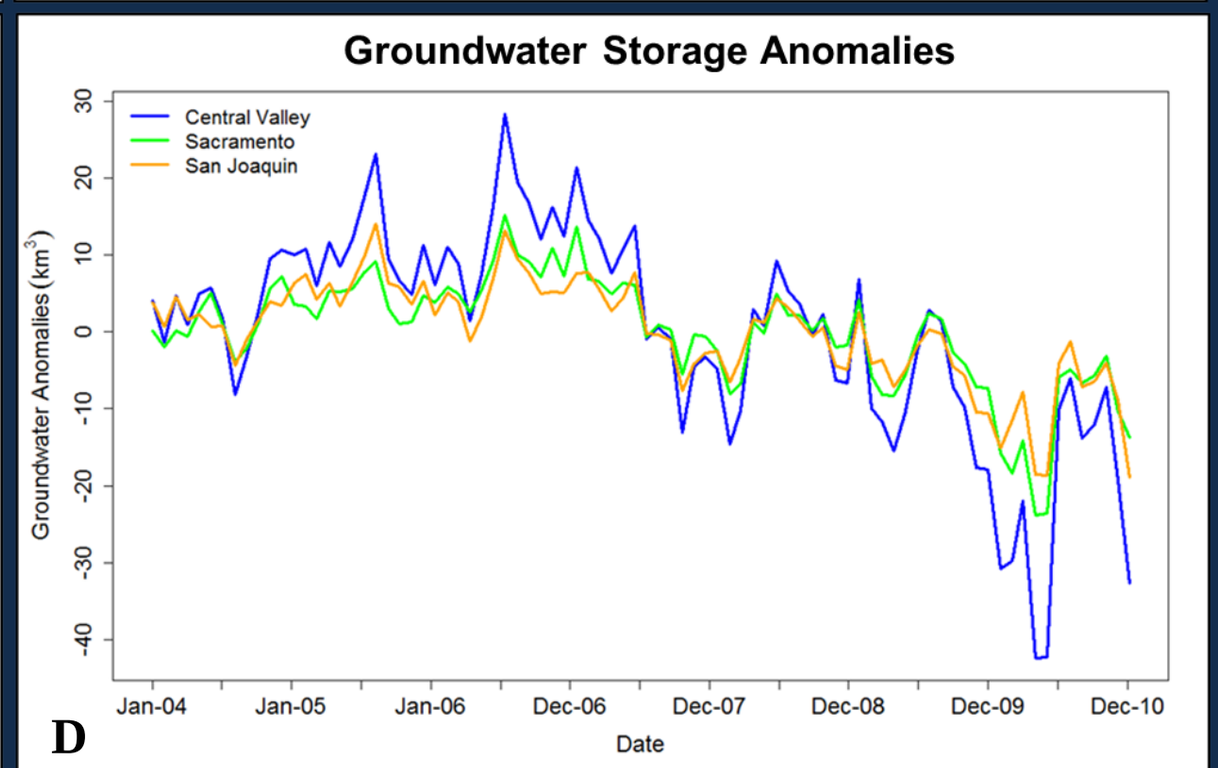
STORAGE ANOMALIES

Q2









MONTHLY GROUNDWATER STOAGE ESTIMATES

Q4